

E 1-28. SOLAR / 2009 - 79 / 03

SOLAR/2009-79/03

Alpha 125975

Monthly Performance Report



RADEMAKER CORPORATION

MARCH 1979



U.S. Department of Energy

National Solar Heating and
Cooling Demonstration Program

National Solar Data Program

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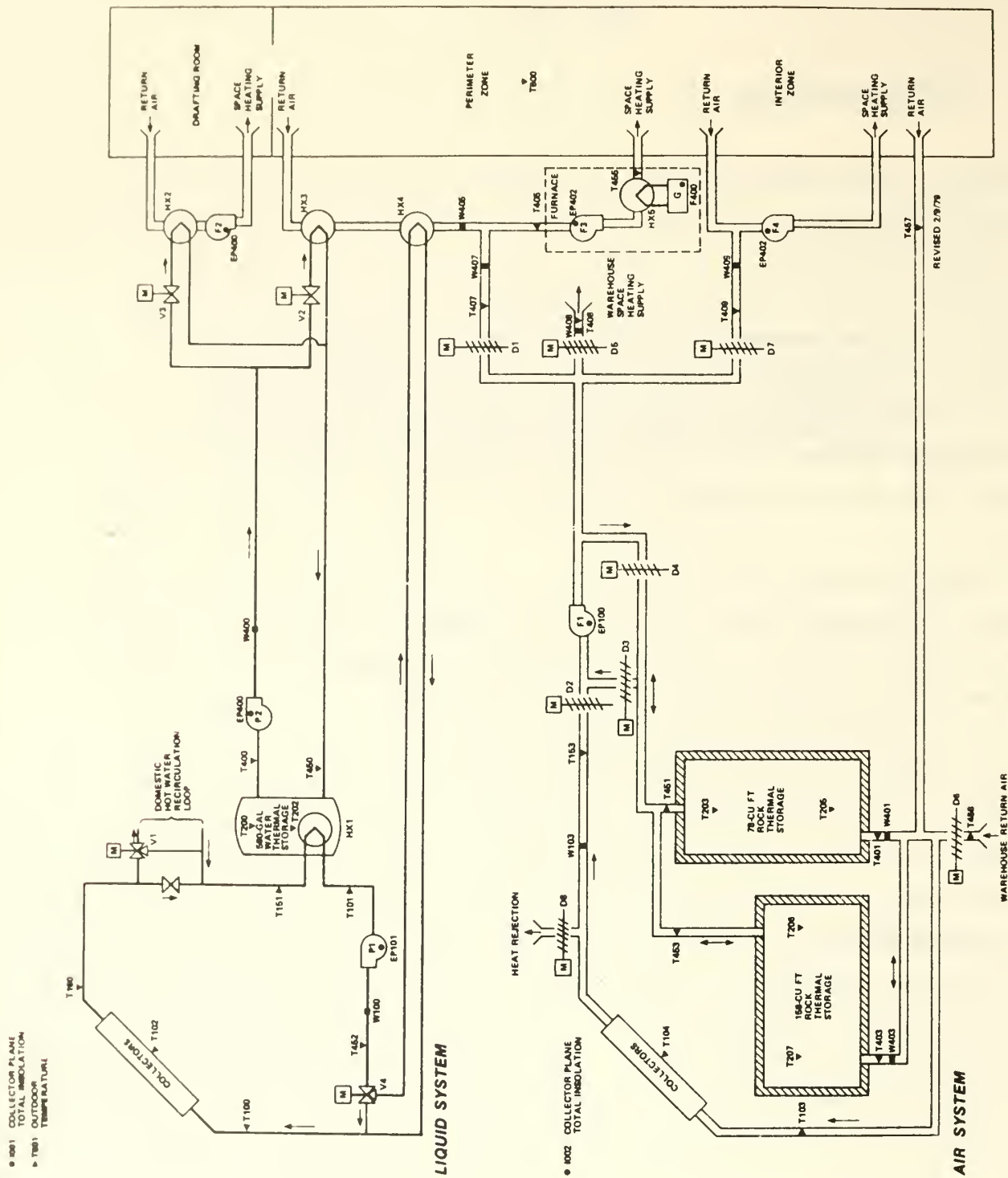
MONTHLY PERFORMANCE REPORT
RADEMAKER CORPORATION
MARCH 1979

I. SYSTEM DESCRIPTION

The solar energy heating system at Rademaker Corporation is designed to provide 50 percent of the space heating and 50 percent of the domestic hot water preheating for a 10,000-square foot office and warehouse building in Louisville, Kentucky. The solar installation, by design, consists of two separate solar energy systems. One system utilizes liquid as the energy transfer medium; the other system utilizes air as the transfer medium. The purpose of separate solar energy systems was to evaluate the merits of each system in meeting a common space heating load. The two solar heating systems are shown schematically in Figure 1.

The liquid system has an array of six flat-plate collectors with a gross area of 240 square feet. The array faces south at an angle of 53 degrees from the horizontal. A solution of 46 percent propylene glycol and 54 percent water is employed as a heat transfer medium. Solar energy is stored in a 560-gallon thermal storage tank located in the warehouse. Solar energy is transferred to meet the space heating demand by two methods. In the first method, solar heated hot water is circulated on demand, from water thermal storage to heat exchangers HX2 and HX3 in the supply ducts of the drafting room and perimeter zone, respectively. In the second method, the glycol and water solution in the collection loop is directed, on demand, to heat exchanger HX4 in the supply duct of the perimeter zone. Circulation fans F2 and F3 distribute the solar energy to meet the space heating loads. Energy is also distributed to a domestic hot water heat exchanger that extracts solar energy from the glycol and water solution to preheat domestic hot water in the building.

The air system has an array of 10 flat-plate collectors with a gross area of 195 square feet. The array faces south at an angle of 33 degrees



from the horizontal. Solar energy is stored in two rock thermal storage units in the warehouse which contain a total of 236 cubic feet of crushed rock. Solar energy is transferred to meet the perimeter, warehouse, and interior zone space heating demands using circulation fan F1. Circulation fans F3 and F4 distribute energy to the perimeter and interior zones, respectively. Solar heated air can be distributed directly from the collectors, or from rock thermal storage to meet the space heating loads. The solar energy control system determines which space heating load received solar energy when a demand exists. The solar space heating load priorities are: first, interior zone heating; second, perimeter zone heating; and third, warehouse heating.

Solar heated air from the liquid system is mixed in the air-handling unit plenum with solar heated air from the air system and distributed to the perimeter zone using circulation fan F3. When solar energy is inadequate to provide perimeter zone space heating, auxiliary thermal energy is supplied by a natural-gas furnace.

The liquid system has four modes of operation.

Mode 1 - Collector-to-Storage: This mode is entered when the difference between the collector outlet temperature and the water thermal storage temperature is greater than 14°F. Pump P1 circulates the liquid through the collectors, then to storage heat exchanger HX1 and returns to the collectors. Circulation continues in this mode until the temperature difference between the collector outlet and storage is less than 4°F.

Mode 2 - Storage-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, a demand for space heating exists; secondly, the temperature of the storage water is above 85°F. Water is circulated from storage to heat exchangers HX2 and HX3 located in the supply ducts of the drafting room and perimeter zone. Air circulation fans F2 and F3 distribute the solar energy to the space heating zones. This mode continues until the storage temperature is below 85°F or the demand for space heating is satisfied.

Mode 3 - Collector-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, the temperature of the liquid at the outlet side of heat exchanger HX1 is greater than 120°F; secondly, there is a demand for space heating from the perimeter zone. Solar energy is directed by valve V4 to heat exchanger HX4 in the supply duct of the perimeter zone. Fan F3 distributes the solar energy to the perimeter zone. This mode continues until either the temperature at the outlet of heat exchanger HX1 is less than 120°F, or the demand for space heating is satisfied. Auxiliary space heating supplements solar energy for the perimeter zone.

Mode 4 - Domestic Hot Water Preheating: This mode is entered when solar hot water heating is desired and solar energy is available from the collectors. Solar energy is directed from the collector loop through the domestic hot water (DHW) recirculation loop to preheat hot water for DHW consumption. A high limit thermostat shuts off the flow to the DHW heat exchanger in the recirculation loop when the liquid temperature exceeds 180°F.

The air system has four modes of operation.

Mode 5 - Auxiliary Space Heating: This mode is entered when the collectors are inactive, the storage temperatures of both solar systems are below 85°F, and a demand for space heating exists. Circulation fan F3 supplies auxiliary energy from the furnace to the perimeter zone. Circulation continues in this mode until the demand for space heating is satisfied or solar energy is available from either the collectors or storage.

Mode 6 - Collector-to-Storage: This mode is entered when two conditions are satisfied: first, the difference between the collector outlet temperature and the bottom of storage is greater than 14°F; secondly, there is no demand for space heating. Fan F1 circulates air from storage, through the collectors, and then back to storage. Circulation continues in this mode until the differential temperature is less than 4°F, or until a demand for space heating occurs. In this mode, motorized dampers

D1, D3, D5, D6, D7 and D8 are closed, and motorized dampers D2 and D4 are opened.

Mode 7 - Storage-to-Conditioned Space: This mode is entered when a demand for heating exists, the collector loop is inactive, and the top of rock thermal storage is above 85°F. Fan F1 circulates building return air through storage and supplies solar heated air to the space heating zone demanding heat. The solar control system determines which space heating zone is supplied with heat. Circulation continues in this mode until the storage temperature drops below 85°F, or the demand for space heating ceases. In this mode, motorized dampers D1, D5, D6 and D7 are opened, or closed, depending upon which area requires heat. For proper air circulation through storage, dampers D2 and D4 are closed, and D3 is opened.

Mode 8 - Collector-to-Conditioned Space: This mode is entered when two conditions are satisfied: first, a demand for space heating exists from the perimeter zone, interior zone, or warehouse; secondly, the differential temperature between the collector outlet and the bottom of rock thermal storage is greater than 14°F. Fan F1 circulates air from conditioned space through the collectors and supplies solar heated air to area demanding heat. The solar control system has a priority scheme that determines the order in which zone is supplied heat. Fans F3 and F4 assist in the air distribution. This mode continues until either the differential temperature between the collector outlet and the bottom of storage is less than 4°F, or the demand for space heating ceases. The auxiliary furnace supplements solar energy for the perimeter zone only. In this mode, motorized dampers D1, D5, D6 and D7 are either opened, or closed, as determined by heating requirements. To circulate air only through the collectors, motorized dampers D3, D4 and D8 are closed, and damper D2 is opened.

The liquid system and the air system operate independently; however, either system may be used in conjunction with the auxiliary furnace to satisfy a heating demand.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluations Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

During March, 32 percent of the 7.858 million Btu space heating system load was provided by solar energy, resulting in a fossil energy savings of 6.18 million Btu at an electrical energy cost of 0.65 million Btu.

For the air system, 31 percent of the 4.05 million Btu system load was provided by solar energy, resulting in a fossil energy savings of 2.43 million Btu at an electrical energy cost of 0.30 million Btu. The energy collection and storage subsystem and the space heating subsystem were operational during the entire month.

For the liquid system, 34 percent of the 3.81 million Btu space heating system load was provided by solar energy, resulting in a fossil energy savings of 2.56 million Btu at an electrical energy cost of 0.34 million Btu. The energy collection and storage subsystem, the space heating subsystem, and the DHW preheating subsystem were operational during the entire month.

B. Weather

During March, the temperature in Louisville, Kentucky was warmer than normal, as evidenced by an average outside ambient temperature of 48°F when compared to the long-term value of 43°F. This long-term value was obtained from the climatological data for the city of Louisville, Kentucky.

In addition, there was more cloud cover than nominal, as evidenced by an average insolation of $1,069 \text{ Btu/ft}^2\text{-day}$ when compared to the long-term value of $1,260 \text{ Btu/ft}^2\text{-day}$. The long-term value was obtained from an algorithm that projects the mean daily horizontal insolation into the plane of the collectors.

C. Thermal Performance (Liquid System)

Collector - During March, 7.95 million Btu of solar energy were incident upon the collector array, and 6.87 million Btu were incident during the operation of the subsystem. From this amount, 2.47 million Btu were collected, resulting in a collector array efficiency of 31 percent, an operational efficiency of 36 percent. A total of 0.14 million Btu of electrical energy was required to operate the subsystem.

Storage - From the 2.47 million Btu of solar energy that were collected, 0.60 million Btu were delivered to the DHW preheating subsystem, 1.62 million Btu were delivered to thermal storage, 0.08 million Btu were delivered directly to the space heating subsystem, and the remaining 0.17 million Btu were lost during transport. The amount that was delivered directly to the space heating subsystem occurred from leakage around closed, motorized valve V4 whenever pump P1 operated. From storage, 1.20 million Btu were removed from the space heating subsystem and 0.44 million Btu were lost to the warehouse, resulting in a storage efficiency of 73 percent. The average storage temperature was 86°F .

Space Heating - A total of 1.28 million Btu of solar energy was delivered to the subsystem. Of the total auxiliary energy used (5.35 million Btu), 2.53 million Btu of thermal energy were apportioned to the liquid system. A total of 1.2 million Btu of electrical energy was required to operate the subsystem, including the apportioned furnace air handler blower power. Solar energy supplied 34 percent of the 3.81 million Btu subsystem load, resulting in a fossil energy savings of 2.56 million Btu, at an electrical energy cost of 0.34 million Btu.

Domestic Hot Water - The DHW subsystem is instrumented to identify the energy extracted from the collected energy and delivered to the DHW recirculation loop. The operating energy and the energy used by the DHW load cannot be identified. The solar energy delivered to the subsystem was 0.60 million Btu.

D. Thermal Performance (Air System)

Collector - During March, 6.49 million Btu of solar energy were incident upon the collector array, and 6.00 million Btu were incident during the operation of the subsystem. From the incident energy, a net amount of 1.57 million Btu were collected.

Due to the premature operation and, to a smaller extent, the late operation of fan F1, the temperature of air entering the collectors was greater than the temperature of air that was leaving for short periods of time. As a result, 0.05 million Btu of thermal energy was transferred from the office area to the collectors and subsequently dissipated to the environment. This process was accelerated when the subsystem cycled frequently during periods of marginal or intermittent insolation. In addition, the net daily value for collected solar energy and solar energy used was negative on four days and three days, respectively. Consequently, the amount of collected solar energy and collector array efficiency were smaller than expected. The net collector array efficiency was 24 percent, an operational efficiency of 26 percent. A total of 0.27 million Btu of electrical energy was required to operate the subsystem.

Storage - From the net amount of 1.57 million Btu of solar energy that was collected, 0.68 million Btu were delivered to storage, 0.83 million Btu were delivered directly to the space heating subsystem, and the remaining 0.06 million Btu were lost during transport. From storage, a gross amount of 0.39 million Btu was removed for the space heating subsystem and 0.33 million Btu were lost to the warehouse.

When there was a requirement for heat in the perimeter zone, motorized damper D1 opened, regardless of the availability of solar energy from either the collectors or thermal storage. Air was drawn from the office area, through thermal storage, and around closed, motorized dampers D3 and D4 by fan F3 in the associated air-handling unit. When the temperature of air entering thermal storage was greater than the temperature of air that was leaving, thermal energy was transferred from the office area to the storage unit and subsequently stored. This amounted to 0.06 million Btu. In addition, the net daily value for energy from storage was negative on six days. Consequently, the tabulated amount of energy from storage and storage efficiency were smaller than expected. The net energy from storage was 0.33 million Btu and the storage efficiency was 52 percent. The average daily storage tank temperature was 69°F which is below the 85°F set point for storage to conditioned space operation (Mode 7).

Space Heating Subsystem - A total of 1.22 million Btu of solar energy was delivered to the subsystem. Of the total auxiliary energy used (5.35 million Btu), 2.83 million Btu of thermal energy were apportioned to the air system. A total of 0.87 million Btu of electrical energy was required to operate the subsystem, including the apportioned furnace air handler blower power. Solar energy supplied 31 percent of the 4.05 million Btu subsystem load, resulting in a fossil energy savings of 2.43 million Btu, at an electrical energy cost of 0.30 million Btu.

As mentioned in Section I, this system has two rock thermal storage units - a 78-cubic foot main unit that is located in the warehouse, and a 158-cubic foot auxiliary unit that is located under an office. Although the auxiliary unit is larger, the nominal volumetric flow rate of air through it was one-twelfth the rate of air through the main unit. As a result, only 0.07 million Btu of solar energy were delivered to the auxiliary unit compared to 0.68 million Btu that were delivered to the main unit. In addition, there was essentially zero thermal energy removed from this unit, whereas a net value of 0.33 million Btu were removed from the main unit. Finally, the average temperature of the auxiliary unit was 63°F as opposed to 75°F for the main unit. Therefore, auxiliary rock thermal storage performed a negligible function in the operation of this system.

E. Thermal Performance (Combined Systems)

The thermal performance of the combined liquid and air systems includes the solar energy extracted from the liquid collector loop for use by the DHW subsystem in the calculation for fossil savings and solar fraction. It has not been included in the total load or solar energy used because the auxiliary DHW energy is unknown. Accordingly, the solar fraction of the overall system is high because the missing auxiliary energy factor which, as a nominal part of the total load, is in the denominator of the solar fraction expression. The Rademaker DHW load is estimated to be 10 percent or less of the heating load and, therefore, this effect is not great.

A total of 2.51 million Btu of solar energy was delivered to the space heating subsystems and 0.60 million Btu were delivered to the DHW pre-heating subsystem. From the 11.59 million Btu of fossil energy available to the furnace, 5.35 million Btu of thermal energy were delivered to heat exchanger HX5. A total of 2.48 million Btu of electrical energy was required to operate the systems in order to maintain an average inside daily building temperature of 72°F. The solar fraction was 32 percent. The solar energy used resulted in fossil energy savings of 6.18 million Btu, at an electrical energy cost of 0.65 million Btu.

F. Observations

The liquid system operation is nominal except for a persistent leak around normally closed valve V4. This effect was measurable (0.08 million Btu) but of little consequence. Storage tank temperatures continue to be very low (86°F). This design deficiency is not easily fixed by retrofit. The relatively low solar fraction of 31 percent is more strongly affected by the design than by weather conditions.

The air system has exhibited the same recurring problems with air leaks as previously reported. Until the malfunction in damper D1 controller is repaired, air flow will be spurious and not as designed. This has complicated analysis but more importantly, the furnace interaction with the solar system ducting has resulted in lowered efficiency.

G. Energy Savings

During March, the combined system fossil energy savings, including the solar contribution to the DHW Subsystem, were 6.18 million Btu. These savings are based on a furnace efficiency of 0.50 in the conversion of fossil energy to usable thermal energy. The electrical energy savings were -0.65 million Btu which is the equivalent operating energy that would have been required to satisfy the observed monthly load by the gas furnace less the operating energy that was used.

The following percentage of time of the month of March that the air system operated in the solar mode and the total system operated in the non-solar modes is listed:

| | |
|------------------------|--------------|
| No Solar Operation | 7.5 Percent |
| Solar Operation | 56.7 Percent |
| Auxiliary Heating Only | 11.8 Percent |
| Ventilating Only | 43.3 Percent |

During solar operation, the air system had the following breakdown of time duration:

| | |
|----------------------|--------------|
| Collector-to-Load | 10.5 Percent |
| Storage-to-Load | 6.3 Percent |
| Collector-to-Storage | 20.6 Percent |

From the latter data, one observes that the air system is characterized as a direct delivery system and that too much time and too much operating energy are used to put energy into storage for the time that it is used to satisfy the heating demand.

It is difficult to derive from the data when solar energy was available for collector-to-load operation and was not used in favor of the ventilation mode. It appears that because of damper leakage, sufficient solar

energy is drawn into the office during high insolation midday periods to satisfy the heating demand, or exceed it in some cases. This heat transfer takes place by the spurious flow paths created by the pressure generated by ventilating blower fan F3.

III. ACTION STATUS

The site contractor has an open action item to correct the damper leaks and the control of damper D1 which now opens when there is a demand for heating regardless of whether solar energy is available. It has also been recommended to the site contractor that the 158-cubic foot rock thermal storage be completely disabled.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2000q-70/02

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ. FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING AIR THROUGH 10 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO EITHER THE OFFICE AREA OR TO A 236 CU. FT. THERMAL STORAGE UNIT. THE SYSTEM IS AUGMENTED BY HEAT FROM A 125,000 BTU/HR. NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY
6.486 MILLION BTU
33263 BTU/SQ. FT.
1.568 MILLION BTU
8041 BTU/SQ. FT.
48 DEGREES F
72 DEGREES F

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

0.19 MILLION BTU
0.273 MILLION BTU
1.141 MILLION BTU
8.900 MILLION BTU

SUBSYSTEM SUMMARY:

LOAD
SOLAR FRACTION USED
SOLAR ENERGY USED
OPERATING ENERGY
AUX. THERMAL ENERGY
AUX. ELECTRIC FUEL
AUX. FOSSIL FUEL
ELECTRICAL SAVINGS
FOSSIL SAVINGS

HEATING
4.048
31
1.222
0.868
2.827
N.A.
6.190
-0.031
2.434
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL
4.048 MILLION BTU
31 PERCENT
1.222 MILLION BTU
1.141 MILLION BTU
2.827 MILLION BTU
N.A. MILLION BTU
6.190 MILLION BTU
-0.034 MILLION BTU
2.434 MILLION BTU

SYSTEM PERFORMANCE FACTOR:

0.405

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: RADEMAKER CORP.--AIR SYSTEM
REPORT PERIOD: MARCH, 1978

SOLAR/0000-70/72

SITE/SYSTEM DESCRIPTION:
THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER BY HEATING END A 10,000 SQ. FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING AIR THROUGH 10 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO EITHER THE OFFICE AREA OR TO A 236 CU. FT. THERMAL STORAGE UNIT. THE SYSTEM IS AUGMENTED BY HEAT FROM A 125,000 BTU/HR. NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

6.842 GIGA JOULES
277733 KJ/SQ.M.
1.654 GIGA JOULES
01310 KJ/SQ.M.
22 DEGREES C
0.10
0.288 GIGA JOULES
1.204 GIGA JOULES
9.390 GIGA JOULES

SURSYSTEM SUMMARY:

LOAD
SOLAR FRACTION
SOLAR ENERGY USED
OPERATING ENERGY
AUX. THERMAL FNG
AUX. ELECTRIC FUEL
AUX. FOSSIL FUEL
ELECTRICAL SAVINGS
FOSSIL SAVINGS

HOT WATER
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

HEATING
4.271
21
1.289
0.916
2.982
N.A.
6.531
-0.032
2.567

COOLING
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL
4.271 GIGA JOULES
21 PERCENT
1.289 GIGA JOULES
1.204 GIGA JOULES
2.982 GIGA JOULES
N.A. GIGA JOULES
6.531 GIGA JOULES
-0.032 GIGA JOULES
2.567 GIGA JOULES

SYSTEM PERFORMANCE FACTOR:

0.405

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SCLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT

ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2009-79/03

| DAY OF MONTH | INCIDENT SOLAR ENERGY MILLION BTU | AMBIENT TEMP DEG-F | ENERGY TO LOADS MILLION BTU | AUX THERMAL TO ECSS MILLION BTU | ECSS OPERATING ENERGY MILLION BTU | ECSS ENERGY REFLECTED MILLION BTU | ECSS SOLAR CONVERSION EFFICIENCY |
|--------------------|---|--------------------------|---|---|---|---|--|
| 1 | 0.059 | 45 | 0.003 | NOT | 0.003 | NOT | 0.056 |
| 2 | 0.258 | 45 | 0.048 | NOT | 0.000 | NOT | 0.185 |
| 3 | 0.047 | 54 | -0.005 | NOT | 0.011 | NOT | -0.108 |
| 4 | 0.176 | 54 | -0.035 | NOT | 0.012 | NOT | -0.201 |
| 5 | 0.044 | 38 | -0.003 | NOT | 0.001 | NOT | -0.073 |
| 6 | 0.421 | 42 | 0.075 | NOT | 0.011 | NOT | 0.179 |
| 7 | 0.127 | 43 | 0.027 | NOT | 0.008 | NOT | 0.211 |
| 8 | 0.174 | 45 | 0.026 | NOT | 0.008 | NOT | 0.149 |
| 9 | 0.150 | 45 | 0.025 | NOT | 0.011 | NOT | 0.159 |
| 10 | 0.246 | 38 | 0.055 | NOT | 0.008 | NOT | 0.224 |
| 11 | 0.203 | 25 | 0.021 | NOT | 0.010 | NOT | 0.103 |
| 12 | 0.448 | 38 | 0.030 | NOT | 0.009 | NOT | 0.177 |
| 13 | 0.167 | 51 | 0.066 | NOT | 0.008 | NOT | 0.180 |
| 14 | 0.366 | 41 | 0.084 | NOT | 0.011 | NOT | 0.188 |
| 15 | 0.446 | 37 | 0.055 | NOT | 0.011 | NOT | 0.207 |
| 16 | 0.457 | 50 | 0.098 | NOT | 0.012 | NOT | 0.242 |
| 17 | 0.405 | 63 | 0.089 | NOT | 0.011 | NOT | 0.271 |
| 18 | 0.329 | 60 | 0.036 | NOT | 0.009 | NOT | 0.259 |
| 19 | 0.138 | 62 | 0.031 | NOT | 0.011 | NOT | 0.237 |
| 20 | 0.130 | 64 | 0.066 | NOT | 0.010 | NOT | 0.221 |
| 21 | 0.148 | 63 | 0.045 | NOT | 0.006 | NOT | 0.302 |
| 22 | 0.183 | 57 | 0.023 | NOT | 0.001 | NOT | 0.123 |
| 23 | 0.034 | 30 | 0.018 | NOT | 0.009 | NOT | 0.540 |
| 24 | 0.104 | 30 | -0.015 | NOT | 0.010 | NOT | -0.149 |
| 25 | 0.250 | 36 | 0.039 | NOT | 0.008 | NOT | 0.157 |
| 26 | 0.100 | 38 | 0.006 | NOT | 0.011 | NOT | 0.061 |
| 27 | 0.214 | 55 | 0.036 | NOT | 0.010 | NOT | 0.167 |
| 28 | 0.119 | 66 | 0.028 | NOT | 0.011 | NOT | 0.239 |
| 29 | 0.195 | 67 | 0.039 | NOT | 0.011 | NOT | 0.198 |
| 30 | 0.041 | 57 | 0.013 | NOT | 0.004 | NOT | 0.317 |
| SUM | 6.486 | - | 1.222 | N.A. | 0.273 | N.A. | - |
| AVG | 0.209 | 48 | 0.039 | N.A. | 0.009 | N.A. | 0.188 |
| NRS ID | Q001 | N113 | | | Q102 | | N111 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT COLLECTOR ARRAY PERFORMANCE

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2000-70/03

| DAY OF MONTH | INCIDENT SOLAR ENERGY MILLION BTU | OPERATIONAL INCIDENT ENERGY MILLION BTU | COLLECTED SOLAR ENERGY MILLION BTU | DAYTIME AMBIENT TEMP °F | COLLECTOR ARRAY EFFICIENCY |
|--------------------|---|---|--|-------------------------------|----------------------------------|
| 1 | 0.059 | 0.033 | 0.001 | 48 | 0.012 |
| 2 | 0.258 | 0.243 | 0.063 | 52 | 0.244 |
| 3 | 0.047 | 0.043 | -0.007 | 57 | -0.140 |
| 4 | 0.176 | 0.172 | -0.003 | 60 | -0.243 |
| 5 | 0.044 | 0.008 | -0.005 | 40 | -0.078 |
| 6 | 0.421 | 0.406 | 0.015 | 52 | 0.250 |
| 7 | 0.127 | 0.115 | 0.012 | 53 | 0.218 |
| 8 | 0.174 | 0.163 | 0.010 | 51 | 0.229 |
| 9 | 0.159 | 0.144 | 0.015 | 47 | 0.182 |
| 10 | 0.246 | 0.236 | 0.010 | 45 | 0.242 |
| 11 | 0.203 | 0.178 | 0.026 | 45 | 0.130 |
| 12 | 0.448 | 0.421 | 0.023 | 20 | 0.274 |
| 13 | 0.167 | 0.147 | 0.020 | 55 | 0.195 |
| 14 | 0.366 | 0.335 | 0.031 | 58 | 0.237 |
| 15 | 0.446 | 0.433 | 0.013 | 44 | 0.252 |
| 16 | 0.457 | 0.419 | 0.038 | 39 | 0.266 |
| 17 | 0.405 | 0.392 | 0.013 | 55 | 0.303 |
| 18 | 0.329 | 0.325 | 0.004 | 66 | 0.365 |
| 19 | 0.138 | 0.131 | 0.007 | 70 | 0.300 |
| 20 | 0.130 | 0.119 | 0.011 | 60 | 0.314 |
| 21 | 0.209 | 0.288 | 0.076 | 70 | 0.320 |
| 22 | 0.148 | 0.139 | 0.004 | 72 | 0.300 |
| 23 | 0.183 | 0.168 | 0.015 | 59 | 0.222 |
| 24 | 0.034 | 0.007 | -0.002 | 37 | -0.096 |
| 25 | 0.250 | 0.081 | -0.010 | 31 | -0.219 |
| 26 | 0.100 | 0.232 | 0.055 | 40 | 0.031 |
| 27 | 0.214 | 0.082 | 0.003 | 40 | 0.283 |
| 28 | 0.119 | 0.208 | 0.061 | 63 | 0.282 |
| 29 | 0.195 | 0.116 | 0.033 | 72 | 0.309 |
| 30 | 0.041 | 0.193 | 0.060 | 57 | 0.050 |
| 31 | 0.041 | 0.028 | 0.002 | | |
| SUM | 6.486 | 6.003 | 1.568 | - | - |
| AVG | 0.209 | 0.194 | 0.051 | 54 | 0.242 |
| NBSID | 0001 | | 0100 | | N100 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT STORAGE PERFORMANCE

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2000-79/03

| DAY OF MONTH | ENERGY TC STORAGE MILLION BTU | ENERGY FROM STORAGE MILLION BTU | CHANGE IN STORED ENERGY MILLION BTU | STORAGE AVERAGE TEMP DEG F | STORAGE EFFICIENCY |
|--------------------|---|---|---|-------------------------------------|-----------------------|
| 1 | 0.001 | -0.004 | -0.004 | 65 | -10.003 |
| 2 | 0.029 | 0.013 | 0.010 | 68 | 0.789 |
| 3 | 0.001 | 0.003 | -0.011 | 65 | -6.796 |
| 4 | 0.008 | -0.001 | -0.001 | 65 | -0.252 |
| 5 | 0.000 | -0.009 | -0.000 | 64 | 1.000 |
| 6 | 0.050 | 0.026 | 0.016 | 70 | 0.847 |
| 7 | 0.016 | 0.011 | -0.006 | 66 | 0.286 |
| 8 | 0.023 | 0.005 | 0.012 | 68 | 0.766 |
| 9 | 0.015 | 0.010 | -0.009 | 68 | 0.052 |
| 10 | 0.004 | 0.003 | -0.015 | 65 | -3.050 |
| 11 | 0.001 | 0.007 | -0.005 | 62 | -17.282 |
| 12 | 0.054 | 0.027 | 0.021 | 69 | 0.893 |
| 13 | 0.017 | 0.010 | -0.001 | 66 | 0.520 |
| 14 | 0.050 | 0.024 | 0.007 | 70 | 0.804 |
| 15 | 0.051 | 0.028 | 0.001 | 71 | 0.589 |
| 16 | 0.042 | 0.034 | 0.003 | 71 | 0.717 |
| 17 | 0.047 | 0.025 | 0.000 | 71 | 0.601 |
| 18 | 0.021 | 0.020 | -0.002 | 73 | 0.861 |
| 19 | 0.022 | 0.013 | -0.005 | 72 | 0.380 |
| 20 | 0.044 | 0.009 | -0.003 | 73 | 0.556 |
| 21 | 0.023 | 0.019 | -0.017 | 76 | 0.813 |
| 22 | 0.017 | 0.021 | -0.014 | 74 | 0.310 |
| 23 | 0.000 | 0.002 | -0.011 | 76 | 0.791 |
| 24 | 0.000 | 0.019 | -0.049 | 60 | 1.000 |
| 25 | 0.022 | -0.003 | -0.014 | 63 | 1.000 |
| 26 | 0.004 | 0.005 | -0.012 | 64 | 0.769 |
| 27 | 0.000 | 0.001 | -0.005 | 64 | -1.020 |
| 28 | 0.020 | -0.000 | 0.027 | 68 | 0.903 |
| 29 | 0.019 | 0.011 | 0.004 | 71 | 0.811 |
| 30 | 0.031 | 0.008 | 0.015 | 74 | 0.752 |
| 31 | 0.001 | 0.011 | -0.023 | 72 | -10.744 |
| SUM | 0.670 | 0.334 | 0.017 | - | - |
| AVG | 0.022 | 0.011 | 0.001 | 69 | 0.517 |
| NBS ID | Q200 | Q201 | Q202 | | N10R |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR/2000-79/02

| DAY OF MON. | HOT WATER LOAD MILLION BTU | SOLAR FR. OF LOAD PER CENT | SOLAR ENERGY USED MILLION BTU | OPER. ENERGY MILLION RTU | AUX. THERMAL USED MILLION RTU | AUX. ELECT. FUEL MILLION BTU | AUX. FOSSIL FUEL MILLION RTU | ELECT. ENERGY SAVINGS MILLION RTU | FOSSIL ENERGY SAVINGS MILLION BTU | SUP. WAT. TEMP. DEG F | HNT. WAT. TEMP. DEG F | HNT. WATER USED GAL |
|-------------------|--|--|---|-----------------------------------|---|--|--|---|---|--------------------------------|--------------------------------|------------------------------|
| 1 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |
| 2 | N.A. | - | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | - | - | N.A. |
| 3 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 4 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 5 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 6 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 7 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 8 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 9 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 10 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 11 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 12 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 13 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 14 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 15 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 16 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 17 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 18 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 19 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 20 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 21 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 22 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 23 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 24 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 25 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 26 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 27 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 28 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 29 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 30 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| 31 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| SUM | N.A. | - | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | - | - | N.A. |
| AVG | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| NBS | Q302 | N300 | Q300 | Q303 | Q301 | Q305 | Q306 | Q311 | Q313 | N305 | N307 | N308 |

18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE HEATING SUBSYSTEM

SOLAR/2000-70/03

SITE: RADEMAKER CORP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979

| DAY OF MON. | SPACE HEATING LOAD MILLION BTU | SOLAR FR. OF LOAD PCT | SOLAR ENERGY USED MILLION BTU | OPER ENERGY MILLION BTU | AUX THERMAL USED MILLION BTU | AUX ELECT FUEL MILLION BTU | AUX FOSSIL FUEL MILLION BTU | ELECT ENERGY SAVINGS MILLION BTU | FOSSIL ENERGY SAVINGS MILLION BTU | RDS TEMP DEG. F | AMB TEMP DEG. F |
|-------------------|--|--------------------------------|---|----------------------------------|--|--|---|--|---|--------------------------|--------------------------|
| 1 | 0.099 | 59 | 0.003 | 0.015 | 0.006 | | 0.198 | -0.003 | 0.007 | 72 | 45 |
| 2 | 0.130 | 39 | 0.048 | 0.031 | 0.082 | | 0.151 | -0.002 | 0.095 | 72 | 45 |
| 3 | 0.099 | 31 | -0.005 | 0.020 | 0.104 | | 0.207 | -0.004 | -0.010 | 72 | 54 |
| 4 | 0.116 | 31 | 0.035 | 0.030 | 0.081 | | 0.173 | -0.002 | -0.070 | 72 | 54 |
| 5 | 0.122 | 48 | -0.003 | 0.014 | 0.125 | | 0.249 | -0.002 | -0.006 | 71 | 48 |
| 6 | 0.157 | 16 | 0.075 | 0.046 | 0.082 | | 0.181 | -0.001 | 0.150 | 72 | 42 |
| 7 | 0.165 | 24 | 0.027 | 0.030 | 0.138 | | 0.264 | -0.004 | 0.053 | 72 | 43 |
| 8 | 0.108 | 31 | 0.026 | 0.024 | 0.082 | | 0.201 | -0.001 | 0.052 | 72 | 45 |
| 9 | 0.098 | 31 | 0.025 | 0.021 | 0.072 | | 0.168 | -0.001 | 0.050 | 72 | 45 |
| 10 | 0.199 | 28 | 0.055 | 0.034 | 0.144 | | 0.284 | -0.003 | 0.110 | 72 | 48 |
| 11 | 0.362 | 65 | 0.021 | 0.047 | 0.341 | | 0.689 | -0.005 | 0.042 | 71 | 48 |
| 12 | 0.134 | 22 | 0.090 | 0.029 | 0.171 | | 0.349 | -0.001 | 0.178 | 73 | 41 |
| 13 | 0.152 | 44 | 0.030 | 0.035 | 0.104 | | 0.262 | -0.001 | 0.137 | 73 | 41 |
| 14 | 0.200 | 42 | 0.066 | 0.047 | 0.116 | | 0.161 | -0.001 | 0.167 | 73 | 31 |
| 15 | 0.221 | 43 | 0.084 | 0.049 | 0.127 | | 0.281 | 0.004 | 0.188 | 73 | 37 |
| 16 | 0.168 | 58 | 0.098 | 0.043 | 0.071 | | 0.176 | 0.001 | 0.195 | 73 | 30 |
| 17 | 0.114 | 75 | 0.089 | 0.030 | 0.025 | | 0.042 | -0.001 | 0.178 | 74 | 60 |
| 18 | 0.048 | 86 | 0.036 | 0.012 | 0.012 | | 0.027 | 0.000 | 0.071 | 75 | 62 |
| 19 | 0.036 | 92 | 0.031 | 0.022 | 0.005 | | 0.022 | 0.000 | 0.061 | 73 | 64 |
| 20 | 0.072 | 100 | 0.066 | 0.030 | 0.000 | | 0.013 | 0.000 | 0.132 | 74 | 63 |
| 21 | 0.045 | 100 | 0.045 | 0.015 | 0.000 | | 0.015 | 0.000 | 0.045 | 73 | 57 |
| 22 | 0.023 | 121 | 0.023 | 0.009 | 0.000 | | 0.015 | -0.000 | 0.036 | 71 | 39 |
| 23 | 0.095 | 20 | -0.015 | 0.036 | 0.077 | | 0.176 | -0.002 | -0.031 | 72 | 30 |
| 24 | 0.282 | 20 | 0.039 | 0.037 | 0.298 | | 0.644 | -0.001 | 0.012 | 72 | 36 |
| 25 | 0.216 | 31 | 0.006 | 0.026 | 0.113 | | 0.381 | -0.001 | 0.071 | 72 | 38 |
| 26 | 0.116 | 100 | 0.036 | 0.025 | 0.081 | | 0.260 | -0.002 | 0.012 | 72 | 55 |
| 27 | 0.128 | 100 | 0.028 | 0.002 | 0.000 | | 0.007 | -0.000 | 0.057 | 72 | 66 |
| 28 | 0.039 | 100 | 0.039 | 0.010 | 0.000 | | 0.007 | -0.000 | 0.077 | 73 | 67 |
| 29 | 0.027 | 48 | 0.013 | 0.004 | 0.014 | | 0.036 | -0.000 | 0.026 | 71 | 57 |
| SUM | 4.048 | - | 1.222 | 0.868 | 2.827 | N.A. | 6.120 | -0.031 | 2.434 | - | - |
| AVG | 0.131 | 31 | 0.039 | 0.028 | 0.091 | N.A. | 0.200 | -0.001 | 0.079 | 72 | 48 |
| NBS | Q402 | N400 | Q400 | Q403 | Q401 | | Q410 | Q415 | Q417 | N406 | N113 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: RADEMAKER CORP.-ATO SYSTEM
REPORT PERIOD: MARCH, 1979
SOLAR/2000-79/02

| DAY OF MONTH | TOTAL INSOLATION BTU/SQ.FT | DIFUSE INSOLATION BTU/SQ.FT | AMBIENT TEMPERATURE DEG F | DAYTIME AMBIENT TEMP DEG F | RELATIVE HUMIDITY PERCENT | WIND DIRECTION DEGREES | WIND SPEED M.P.H. |
|--------------------|----------------------------------|-----------------------------------|---------------------------------|-------------------------------------|---------------------------------|------------------------------|-------------------------|
| 1 | 301 | N | 45 | 48 | N | N | N |
| 2 | 1325 | NOT | 45 | 57 | CT | OT | CT |
| 3 | 241 | | 54 | 60 | | | |
| 4 | 901 | | 54 | 40 | | | |
| 5 | 227 | | 38 | 52 | | | |
| 6 | 2160 | | 42 | 51 | | | |
| 7 | 891 | | 45 | 47 | | | |
| 8 | 815 | | 45 | 45 | | | |
| 9 | 1261 | | 38 | 29 | | | |
| 10 | 1042 | | 35 | 58 | | | |
| 11 | 2297 | | 31 | 44 | | | |
| 12 | 856 | | 41 | 35 | | | |
| 13 | 1879 | | 31 | 55 | | | |
| 14 | 2234 | | 37 | 66 | | | |
| 15 | 2077 | | 30 | 77 | | | |
| 16 | 1687 | | 60 | 70 | | | |
| 17 | 708 | | 62 | 69 | | | |
| 18 | 666 | | 64 | 70 | | | |
| 19 | 1532 | | 67 | 70 | | | |
| 20 | 1757 | | 67 | 70 | | | |
| 21 | 940 | | 30 | 75 | | | |
| 22 | 172 | | 30 | 37 | | | |
| 23 | 1531 | | 30 | 31 | | | |
| 24 | 1283 | | 36 | 40 | | | |
| 25 | 512 | | 35 | 40 | | | |
| 26 | 1100 | | 66 | 63 | | | |
| 27 | 609 | | 67 | 72 | | | |
| 28 | 1002 | | 67 | 57 | | | |
| 29 | 208 | | 57 | | | | |
| 30 | | | | | | | |
| 31 | | | | | | | |
| SUM | 33263 | N.A. | - | - | - | - | - |
| AVG | 1073 | N.A. | 48 | 54 | N.A. | N.A. | N.A. |
| NBS ID | Q001 | | N113 | | | N115 | N114 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SCLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT AUXILIARY STORAGE PERFORMANCE

SITE: RADEMAKER COOP.-AIR SYSTEM
REPORT PERIOD: MARCH, 1979
SOLAR/2000-79/03

| DAY OF MONTH | ENERGY TO STORAGE MILLION BTU | ENERGY FROM STORAGE MILLION BTU | INCREASE IN STORED ENERGY MILLION BTU | STORAGE AVERAGE TEMP °F | STORAGE EFFICIENCY |
|--------------------|---|---|---|-------------------------------|-----------------------|
| 1 | 0.000 | -0.000 | -0.000 | 60 | -100.310 |
| 2 | 0.000 | -0.000 | -0.000 | 61 | 22.407 |
| 3 | 0.000 | -0.000 | -0.000 | 61 | 31.845 |
| 4 | 0.001 | -0.000 | -0.000 | 61 | 0.312 |
| 5 | 0.000 | -0.000 | -0.000 | 60 | -153.811 |
| 6 | 0.004 | -0.000 | -0.000 | 61 | 4471.434 |
| 7 | 0.002 | -0.000 | -0.000 | 61 | 50.382 |
| 8 | 0.002 | -0.000 | -0.000 | 62 | 0.850 |
| 9 | 0.002 | -0.000 | -0.000 | 62 | 195.672 |
| 10 | 0.000 | -0.000 | -0.000 | 61 | 16.620 |
| 11 | 0.000 | -0.000 | -0.000 | 60 | 32.244 |
| 12 | 0.005 | -0.000 | -0.000 | 60 | -158.534 |
| 13 | 0.003 | -0.000 | -0.000 | 61 | -17.395 |
| 14 | 0.004 | -0.000 | -0.000 | 62 | 107.544 |
| 15 | 0.005 | -0.000 | -0.000 | 63 | 9.070 |
| 16 | 0.004 | -0.000 | -0.000 | 64 | 6.845 |
| 17 | 0.004 | -0.000 | -0.000 | 65 | -3.164 |
| 18 | 0.003 | -0.000 | -0.000 | 66 | 13.185 |
| 19 | 0.003 | -0.000 | -0.000 | 66 | 43.758 |
| 20 | 0.004 | -0.000 | -0.000 | 67 | -1.389 |
| 21 | 0.003 | -0.000 | -0.000 | 67 | 78.042 |
| 22 | 0.003 | -0.000 | -0.000 | 67 | 1.848 |
| 23 | 0.000 | -0.000 | -0.000 | 66 | 246.520 |
| 24 | 0.002 | -0.000 | -0.000 | 67 | 26.466 |
| 25 | 0.001 | -0.000 | -0.000 | 61 | 10.000 |
| 26 | 0.003 | -0.000 | -0.000 | 61 | -110.545 |
| 27 | 0.002 | -0.000 | -0.000 | 62 | 35.326 |
| 28 | 0.003 | -0.000 | -0.000 | 64 | -42.491 |
| 29 | 0.003 | -0.000 | -0.000 | 65 | -51.764 |
| 30 | 0.001 | -0.000 | -0.000 | 65 | 312.178 |
| 31 | 0.001 | -0.000 | -0.000 | - | - |
| SUM | 0.067 | 0.003 | 0.014 | - | - |
| AVG | 0.002 | 0.000 | 0.000 | 63 | 10.425 |

* DENOTES UNAVAILABLE DATA.

0 DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
EXTRA LOAD SUBSYSTEM

SITE: RADEMAKER CORP.-AIP SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2000-70/03

| DAY OF MONTH | LOAD MILLION BTU | SOLAR FRACTION OF LOAD PERCENT | SOLAR ENERGY USED MILLION BTU | OPER ENERGY MILLION BTU | AUX THERMAL MILLION BTU | AUX ELECT MILLION BTU | AUX FUEL MILLION BTU | ELECT ENERGY SAVINGS MILLION BTU | FUELS ENERGY SAVINGS MILLION BTU |
|--------------------|------------------------|---|---|----------------------------------|----------------------------------|--------------------------------|-------------------------------|--|--|
| 1 | 0.196 | 2 | 0.004 | 0.039 | 0.192 | NOT | 0.397 | -0.016 | 0.014 |
| 2 | 0.246 | 26 | 0.086 | 0.083 | 0.160 | APPLICABLE | 0.290 | -0.021 | 0.221 |
| 3 | 0.209 | 0 | 0.001 | 0.060 | 0.208 | | 0.414 | -0.022 | 0.004 |
| 4 | 0.208 | 19 | 0.035 | 0.080 | 0.173 | | 0.349 | -0.022 | 0.114 |
| 5 | 0.247 | -1 | -0.003 | 0.035 | 0.250 | | 0.495 | -0.012 | 0.006 |
| 6 | 0.303 | 48 | 0.147 | 0.109 | 0.157 | | 0.352 | -0.022 | 0.374 |
| 7 | 0.281 | 19 | 0.050 | 0.085 | 0.229 | | 0.378 | -0.027 | 0.138 |
| 8 | 0.205 | 15 | 0.026 | 0.066 | 0.155 | | 0.337 | -0.021 | 0.080 |
| 9 | 0.170 | 28 | 0.098 | 0.090 | 0.145 | | 0.500 | -0.038 | 0.254 |
| 10 | 0.366 | 5 | 0.028 | 0.097 | 0.268 | | 1.685 | -0.021 | 0.091 |
| 11 | 0.743 | 34 | 0.176 | 0.110 | 0.335 | | 0.686 | -0.021 | 0.448 |
| 12 | 0.511 | 38 | 0.080 | 0.095 | 0.144 | | 0.364 | -0.029 | 0.210 |
| 13 | 0.233 | 46 | 0.139 | 0.090 | 0.162 | | 0.304 | -0.021 | 0.347 |
| 14 | 0.301 | 51 | 0.183 | 0.119 | 0.179 | | 0.481 | -0.020 | 0.441 |
| 15 | 0.359 | 57 | 0.231 | 0.129 | 0.176 | | 0.381 | -0.030 | 0.541 |
| 16 | 0.410 | 70 | 0.240 | 0.126 | 0.106 | | 0.263 | -0.025 | 0.567 |
| 17 | 0.347 | 82 | 0.195 | 0.098 | 0.044 | | 0.115 | -0.010 | 0.460 |
| 18 | 0.239 | 80 | 0.111 | 0.076 | 0.013 | | 0.056 | -0.017 | 0.258 |
| 19 | 0.124 | 82 | 0.048 | 0.087 | 0.011 | | 0.045 | -0.018 | 0.131 |
| 20 | 0.058 | 91 | 0.115 | 0.087 | 0.000 | | 0.026 | -0.016 | 0.287 |
| 21 | 0.126 | 100 | 0.118 | 0.051 | 0.000 | | 0.030 | -0.010 | 0.096 |
| 22 | 0.118 | 100 | 0.072 | 0.043 | 0.155 | | 0.349 | -0.017 | 0.142 |
| 23 | 0.037 | 100 | 0.072 | 0.083 | 0.596 | | 1.287 | -0.017 | 0.013 |
| 24 | 0.226 | 100 | 0.013 | 0.090 | 0.357 | | 0.522 | -0.019 | 0.106 |
| 25 | 0.582 | 103 | -0.041 | 0.072 | 0.226 | | 0.308 | -0.025 | 0.128 |
| 26 | 0.398 | 25 | 0.006 | 0.089 | 0.161 | | 0.013 | -0.015 | 0.106 |
| 27 | 0.232 | 100 | 0.054 | 0.033 | 0.000 | | 0.013 | -0.017 | 0.103 |
| 28 | 0.215 | 100 | 0.041 | 0.046 | 0.000 | | 0.074 | -0.007 | 0.124 |
| 29 | 0.041 | 100 | 0.039 | 0.030 | 0.028 | | | | |
| 30 | 0.039 | 68 | 0.060 | 0.030 | | | | | |
| 31 | 0.088 | | | | | | | | |
| SUM | 7.858 | - | 2.505 | 2.480 | 5.353 | N.A. | 11.592 | -0.645 | 6.183 |
| AVG | 0.253 | 32 | 0.081 | 0.080 | 0.173 | N.A. | 0.374 | -0.021 | 0.199 |

* DENOTES UNAVAILABLE DATA.
 † DENOTES NULL DATA.
 N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2009-79/03

SITE/SYSTEM DESCRIPTION:

THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ. FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING A 46% PROPYLENE GLYCOL SOLUTION THROUGH 6 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO THE DOMESTIC HOT WATER SUBSYSTEM AND TO A 560 GAL. INSULATED TANK. THE SPACE HEATING SUBSYSTEM IS AUGMENTED BY A 125,000 BTU/HR, NATURAL GAS FURNACE.

GENERAL SITE DATA:

| | | |
|----------------------------------|-------|-------------|
| INCIDENT SOLAR ENERGY | 7.950 | MILLION BTU |
| COLLECTED SOLAR ENERGY | 33125 | RTU/SQ. FT. |
| AVERAGE AMBIENT TEMPERATURE | 2.471 | MILLION BTU |
| AVERAGE BUILDING TEMPERATURE | 10205 | RTU/SQ. FT. |
| FCSS SOLAR CONVERSION EFFICIENCY | 48 | DEGREES F |
| FCSS OPERATING ENERGY | 72 | DEGREES F |
| TOTAL SYSTEM OPERATING ENERGY | 0.24 | MILLION BTU |
| TOTAL ENERGY CONSUMED | 1.338 | MILLION BTU |
| | 9.211 | MILLION BTU |

SUBSYSTEM SUMMARY:

| | | | |
|---------------------|-----------|---------|--------------|
| LGAN | HOT WATER | COOLING | SYSTEM TOTAL |
| SOLAR FRACTION | N.A. | N.A. | 3.810 |
| SOLAR ENERGY USED | N.A. | N.A. | 34 |
| OPERATING ENERGY | 0.598 | N.A. | 1.882 |
| AUX. THERMAL ENERGY | N.A. | N.A. | 1.338 |
| AUX. ELECTRIC FUEL | N.A. | N.A. | 2.526 |
| AUX. FOSSIL FUEL | N.A. | N.A. | N.A. |
| ELECTRICAL SAVINGS | N.A. | N.A. | 5.402 |
| FOSSIL SAVINGS | N.A. | N.A. | -0.341 |
| | | | 2.557 |

SYSTEM PERFORMANCE FACTOR:

0.386

* DENOTES UNAVAILABLE DATA

0 DENOTES NULL DATA

N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT

SITE SUMMARY

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1978

SOLAR/2004-78/03

SITE/SYSTEM DESCRIPTION:

THE PURPOSE OF THIS INSTALLATION IS TO PROVIDE SPACE HEATING AND DOMESTIC HOT WATER PREHEATING FOR A 10,000 SQ. FT. OFFICE/WAREHOUSE. THIS IS ACCOMPLISHED BY CIRCULATING A 46% PROPYLENE GLYCOL SOLUTION THROUGH 6 FLAT PLATE COLLECTORS TO TRANSFER SOLAR ENERGY TO THE DOMESTIC HOT WATER SUPSYSTEM AND TO A 560 GAL. INSULATED TANK. THE SPACE HEATING SUPSYSTEM IS AUGMENTED BY A 125,000 BTU/HR. NATURAL GAS FURNACE.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY 8.387 GIGA JOULES
COLLECTED SOLAR ENERGY 376169 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE 2.607 GIGA JOULES
AVERAGE BUILDING TEMPERATURE 116011 KJ/SQ.M.
ECSS SOLAR CONVERSION EFFICIENCY 22 DEGREES C
TOTAL SYSTEM OPERATING ENERGY 0.24 GIGA JOULES
TOTAL ENERGY CONSUMED 1.412 GIGA JOULES
0.717 GIGA JOULES

SUPERSYSTEM SUMMARY:

| | HOT WATER | HEATING | COOLING | SYSTEM TOTAL |
|---------------------|-----------|---------|---------|--------------------|
| LOAD | N.A. | 4.020 | N.A. | 4.020 GIGA JOULES |
| SOLAR FRACTION USED | N.A. | 34 | N.A. | 34 PERCENT |
| SOLAR ENERGY USED | 0.631 | 1.354 | N.A. | 1.986 GIGA JOULES |
| OPERATING ENERGY | N.A. | 1.265 | N.A. | 1.412 GIGA JOULES |
| AUX. THERMAL ENG | N.A. | 2.665 | N.A. | 2.665 GIGA JOULES |
| AUX. ELECTRIC FUEL | N.A. | N.A. | N.A. | N.A. GIGA JOULES |
| AUX. FOSSIL FUEL | N.A. | 5.699 | N.A. | 5.699 GIGA JOULES |
| ELECTRICAL SAVINGS | N.A. | -0.213 | N.A. | -0.360 GIGA JOULES |
| FOSSIL SAVINGS | N.A. | 2.668 | N.A. | 2.668 GIGA JOULES |

SYSTEM PERFORMANCE FACTOR:

0.386

* DENOTES UNAVAILABLE DATA

@ DENOTES NULL DATA

N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT

ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: PADEMAKER CORP.-LIQUID SYSTEM
 REPORT PERIOD: MARCH, 1979

SOLAR/2009-70/02

| DAY OF MONTH | INCIDENT SOLAR ENERGY MILLION BTU | AMBIENT TEMP DEG-F | ENERGY TO LOADS MILLION BTU | AUX THERMAL TO ECSS MILLION BTU | ECSS OPERATING ENERGY MILLION BTU | ECSS ENERGY REFLECTED MILLION BTU | ECSS SOLAR CONVERSION EFFICIENCY |
|--------------------|---|--------------------------|---|---|---|---|--|
| 1 | 0.069 | 45 | 0.004 | NOT APPLICABLE | 0.001 | NOT APPLICABLE | 0.051 |
| 2 | 0.260 | 45 | 0.063 | | 0.005 | | 0.243 |
| 3 | 0.054 | 54 | 0.007 | | 0.000 | | 0.120 |
| 4 | 0.221 | 54 | 0.022 | | 0.006 | | 0.098 |
| 5 | 0.051 | 38 | 0.000 | | 0.007 | | 0.000 |
| 6 | 0.545 | 42 | 0.112 | | 0.004 | | 0.206 |
| 7 | 0.153 | 43 | 0.039 | | 0.003 | | 0.253 |
| 8 | 0.217 | 45 | 0.044 | | 0.003 | | 0.200 |
| 9 | 0.194 | 45 | 0.015 | | 0.003 | | 0.076 |
| 10 | 0.305 | 38 | 0.072 | | 0.006 | | 0.236 |
| 11 | 0.249 | 25 | 0.025 | | 0.004 | | 0.100 |
| 12 | 0.574 | 28 | 0.135 | | 0.007 | | 0.236 |
| 13 | 0.203 | 28 | 0.076 | | 0.005 | | 0.374 |
| 14 | 0.457 | 51 | 0.105 | | 0.006 | | 0.227 |
| 15 | 0.570 | 51 | 0.141 | | 0.007 | | 0.304 |
| 16 | 0.582 | 37 | 0.177 | | 0.007 | | 0.363 |
| 17 | 0.515 | 50 | 0.142 | | 0.007 | | 0.345 |
| 18 | 0.410 | 63 | 0.054 | | 0.006 | | 0.568 |
| 19 | 0.165 | 60 | 0.035 | | 0.005 | | 0.231 |
| 20 | 0.151 | 62 | 0.078 | | 0.005 | | 0.215 |
| 21 | 0.362 | 63 | 0.050 | | 0.005 | | 0.507 |
| 22 | 0.178 | 57 | 0.026 | | 0.003 | | 0.116 |
| 23 | 0.219 | 39 | 0.053 | | 0.000 | | 1.420 |
| 24 | 0.038 | 30 | 0.009 | | 0.002 | | 0.073 |
| 25 | 0.120 | 36 | 0.014 | | 0.002 | | 0.047 |
| 26 | 0.297 | 38 | 0.004 | | 0.002 | | 0.037 |
| 27 | 0.115 | 55 | 0.028 | | 0.007 | | 0.110 |
| 28 | 0.258 | 66 | 0.025 | | 0.006 | | 0.178 |
| 29 | 0.139 | 67 | 0.013 | | 0.006 | | 0.056 |
| 30 | 0.232 | 57 | 0.013 | | 0.006 | | 0.056 |
| 31 | 0.046 | 57 | 0.040 | | 0.001 | | 1.078 |
| SUM | 7.950 | - | 1.882 | N.A. | 0.130 | N.A. | - |
| AVG | 0.256 | 48 | 0.061 | N.A. | 0.004 | N.A. | 0.237 |
| NRS ID | 0001 | N113 | | | G102 | | N111 |

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT COLLECTOR ARRAY PERFORMANCE

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAR/2000-79/03

| DAY OF MONTH | INCIDENT SOLAR ENERGY MILLION BTU | OPERATIONAL INCIDENT ENERGY MILLION BTU | COLLECTED SOLAR ENERGY MILLION BTU | DAYTIME AMBIENT TEMP DEG F | COLLECTOR EFFICIENCY |
|--------------------|---|---|--|-------------------------------------|-------------------------|
| 1 | 0.069 | 0.024 | 0.009 | 48 | 0.126 |
| 2 | 0.260 | 0.220 | 0.116 | 52 | 0.448 |
| 3 | 0.054 | 0.001 | 0.002 | 57 | 0.034 |
| 4 | 0.221 | 0.198 | 0.060 | 60 | 0.313 |
| 5 | 0.545 | 0.000 | 0.000 | 40 | 0.000 |
| 6 | 0.153 | 0.521 | 0.197 | 52 | 0.361 |
| 7 | 0.217 | 0.116 | 0.033 | 53 | 0.213 |
| 8 | 0.194 | 0.181 | 0.073 | 51 | 0.337 |
| 9 | 0.305 | 0.150 | 0.052 | 47 | 0.260 |
| 10 | 0.249 | 0.277 | 0.064 | 45 | 0.307 |
| 11 | 0.574 | 0.182 | 0.057 | 29 | 0.230 |
| 12 | 0.203 | 0.535 | 0.189 | 55 | 0.320 |
| 13 | 0.457 | 0.167 | 0.046 | 58 | 0.228 |
| 14 | 0.570 | 0.426 | 0.154 | 44 | 0.338 |
| 15 | 0.582 | 0.527 | 0.181 | 20 | 0.318 |
| 16 | 0.515 | 0.536 | 0.152 | 55 | 0.331 |
| 17 | 0.410 | 0.485 | 0.101 | 66 | 0.371 |
| 18 | 0.165 | 0.301 | 0.159 | 77 | 0.388 |
| 19 | 0.362 | 0.144 | 0.039 | 70 | 0.238 |
| 20 | 0.178 | 0.339 | 0.047 | 60 | 0.311 |
| 21 | 0.219 | 0.154 | 0.127 | 72 | 0.378 |
| 22 | 0.038 | 0.193 | 0.051 | 50 | 0.289 |
| 23 | 0.120 | 0.000 | 0.072 | 37 | 0.327 |
| 24 | 0.207 | 0.048 | 0.000 | 31 | 0.000 |
| 25 | 0.115 | 0.266 | 0.010 | 31 | 0.083 |
| 26 | 0.258 | 0.054 | 0.060 | 40 | 0.302 |
| 27 | 0.139 | 0.244 | 0.016 | 63 | 0.141 |
| 28 | 0.232 | 0.125 | 0.081 | 63 | 0.312 |
| 29 | 0.046 | 0.216 | 0.038 | 72 | 0.274 |
| 30 | 0.046 | 0.012 | 0.071 | 57 | 0.308 |
| 31 | 0.046 | 0.012 | 0.003 | 57 | 0.072 |
| SUM | 7.950 | 6.872 | 2.471 | - | - |
| AVG | 0.256 | 0.222 | 0.080 | 54 | 0.311 |
| NPS ID | Q001 | | Q100 | | N100 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT STORAGE PERFORMANCE

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1970

SOLAR/2009-79/03

| DAY OF MONTH | ENERGY TO STORAGE MILLION BTU | ENERGY FROM STORAGE MILLION BTU | CHANGE IN STORAGE MILLION BTU | STORAGE AVERAGE TEMP DEG F | STORAGE EFFICIENCY |
|--------------------|---|---|---|-------------------------------------|-----------------------|
| 1 | 0.003 | 0.000 | -0.003 | 79 | -9.652 |
| 2 | 0.086 | 0.037 | -0.039 | 82 | 0.880 |
| 3 | 0.000 | 0.006 | -0.006 | 80 | -112.007 |
| 4 | 0.044 | 0.000 | -0.014 | 80 | 0.317 |
| 5 | 0.000 | 0.000 | -0.000 | 78 | 0.000 |
| 6 | 0.142 | 0.000 | -0.026 | 86 | 1.041 |
| 7 | 0.017 | 0.025 | -0.047 | 85 | -1.327 |
| 8 | 0.048 | 0.023 | -0.010 | 84 | -0.670 |
| 9 | 0.035 | 0.000 | -0.005 | 82 | -0.147 |
| 10 | 0.052 | 0.041 | -0.000 | 84 | 0.178 |
| 11 | 0.022 | 0.000 | -0.013 | 81 | -0.623 |
| 12 | 0.125 | 0.083 | -0.046 | 81 | 1.189 |
| 13 | 0.026 | 0.058 | -0.043 | 87 | 0.609 |
| 14 | 0.110 | 0.068 | -0.033 | 80 | 0.916 |
| 15 | 0.123 | 0.093 | -0.014 | 85 | 0.872 |
| 16 | 0.134 | 0.128 | -0.002 | 87 | 0.974 |
| 17 | 0.112 | 0.122 | -0.007 | 85 | 1.030 |
| 18 | 0.102 | 0.092 | -0.017 | 85 | 1.073 |
| 19 | 0.017 | 0.075 | -0.047 | 89 | 1.661 |
| 20 | 0.026 | 0.018 | -0.003 | 86 | 0.810 |
| 21 | 0.028 | 0.048 | -0.053 | 83 | 1.040 |
| 22 | 0.053 | 0.073 | -0.042 | 81 | 1.007 |
| 23 | 0.000 | 0.012 | -0.012 | 82 | 0.672 |
| 24 | 0.001 | 0.053 | -0.051 | 82 | 1.000 |
| 25 | 0.071 | 0.000 | -0.019 | 74 | 19.273 |
| 26 | 0.009 | 0.000 | -0.016 | 76 | 0.582 |
| 27 | 0.064 | 0.017 | -0.041 | 70 | -1.740 |
| 28 | 0.021 | 0.012 | -0.001 | 82 | 0.912 |
| 29 | 0.055 | 0.000 | -0.031 | 85 | 0.644 |
| 30 | -0.002 | 0.046 | -0.062 | 80 | 0.563 |
| 31 | | | | 86 | 9.813 |
| SUM | 1.620 | 1.198 | -0.416 | - | - |
| AVG | 0.052 | 0.039 | -0.001 | 86 | 0.720 |
| NBS ID | Q200 | Q201 | Q202 | | N108 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1979
SOLAR/2000-79/03

| DAY OF MON. | HOT WATER LOAD MILLION BTU | SOLAR FR. OF LOAD PER CENT | SOLAR ENERGY USED MILLION BTU | OPER ENERGY MILLION BTU | AUX THERMAL USED MILLION BTU | AUX ELECT FUEL MILLION BTU | AUX FOSSIL FUEL MILLION BTU | ELECT ENERGY SAVINGS MILLION BTU | FOSSIL ENERGY SAVINGS MILLION BTU | SUP. WAT. TEMP DEG F | HOT WAT. TEMP DEG F | HOT WATER USED GAL |
|-------------|----------------------------|----------------------------|-------------------------------|-------------------------|------------------------------|----------------------------|-----------------------------|----------------------------------|-----------------------------------|----------------------|---------------------|--------------------|
| 1 | NOT APPLICABLE | NOT APPLICABLE | 0.003 | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE | NOT APPLICABLE |
| 2 | | | 0.024 | | | | | | | | | |
| 3 | | | 0.001 | | | | | | | | | |
| 4 | | | 0.022 | | | | | | | | | |
| 5 | | | 0.000 | | | | | | | | | |
| 6 | | | 0.041 | | | | | | | | | |
| 7 | | | 0.013 | | | | | | | | | |
| 8 | | | 0.014 | | | | | | | | | |
| 9 | | | 0.029 | | | | | | | | | |
| 10 | | | 0.018 | | | | | | | | | |
| 11 | | | 0.049 | | | | | | | | | |
| 12 | | | 0.016 | | | | | | | | | |
| 13 | | | 0.032 | | | | | | | | | |
| 14 | | | 0.041 | | | | | | | | | |
| 15 | | | 0.044 | | | | | | | | | |
| 16 | | | 0.036 | | | | | | | | | |
| 17 | | | 0.018 | | | | | | | | | |
| 18 | | | 0.020 | | | | | | | | | |
| 19 | | | 0.017 | | | | | | | | | |
| 20 | | | 0.011 | | | | | | | | | |
| 21 | | | 0.000 | | | | | | | | | |
| 22 | | | 0.007 | | | | | | | | | |
| 23 | | | 0.013 | | | | | | | | | |
| 24 | | | 0.004 | | | | | | | | | |
| 25 | | | 0.010 | | | | | | | | | |
| 26 | | | 0.012 | | | | | | | | | |
| 27 | | | 0.002 | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | |
| SUM | N.A. | - | 0.568 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | - | - | N.A. |
| AVG | N.A. | N.A. | 0.019 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| NBS | Q302 | N300 | Q300 | Q303 | Q301 | Q305 | Q306 | Q311 | Q313 | N305 | N307 | N309 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE HEATING SUBSYSTEM

SOLAR/2009-79/03

SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1979

| DAY OF MON. | SPACE HEATING LOAD MILLION BTU | SOLAR FR. OF LOAD PCT | SOLAR ENERGY USED MILLION BTU | OPER ENERGY MILLION BTU | AUX THERMAL USED MILLION BTU | AUX ELECT FUEL MILLION BTU | AUX FOSSIL FUEL MILLION BTU | ELECT ENERGY SAVINGS MILLION BTU | FOSSIL ENERGY SAVINGS MILLION BTU | BLDG TEMP DEG. F | AMR TEMP DEG. F |
|-------------------|--|--------------------------------|---|----------------------------------|--|--|---|--|---|---------------------------|--------------------------|
| 1 | 0.096 | 0 | 0.000 | 0.020 | 0.096 | N | 0.199 | -0.009 | 0.001 | 72 | 45 |
| 2 | 0.116 | 33 | 0.039 | 0.038 | 0.078 | C | 0.139 | -0.006 | 0.077 | 72 | 45 |
| 3 | 0.110 | 5 | 0.006 | 0.028 | 0.104 | T | 0.207 | -0.007 | 0.012 | 72 | 54 |
| 4 | 0.092 | 10 | 0.000 | 0.019 | 0.092 | A | 0.176 | -0.003 | 0.000 | 71 | 54 |
| 5 | 0.125 | 40 | 0.071 | 0.045 | 0.125 | P | 0.249 | -0.008 | 0.000 | 72 | 38 |
| 6 | 0.146 | 22 | 0.026 | 0.047 | 0.175 | P | 0.171 | -0.003 | 0.142 | 72 | 42 |
| 7 | 0.117 | 26 | 0.041 | 0.044 | 0.091 | P | 0.164 | -0.015 | 0.051 | 72 | 43 |
| 8 | 0.096 | 26 | 0.001 | 0.034 | 0.072 | L | 0.176 | -0.012 | 0.048 | 72 | 43 |
| 9 | 0.073 | 26 | 0.043 | 0.049 | 0.072 | T | 0.169 | -0.009 | 0.001 | 72 | 45 |
| 10 | 0.167 | 2 | 0.007 | 0.041 | 0.124 | C | 0.216 | -0.019 | 0.085 | 72 | 38 |
| 11 | 0.381 | 34 | 0.086 | 0.052 | 0.374 | A | 0.767 | -0.004 | 0.014 | 71 | 25 |
| 12 | 0.250 | 61 | 0.060 | 0.046 | 0.164 | C | 0.336 | -0.015 | 0.119 | 73 | 31 |
| 13 | 0.099 | 49 | 0.073 | 0.041 | 0.076 | R | 0.143 | -0.006 | 0.145 | 72 | 41 |
| 14 | 0.149 | 62 | 0.099 | 0.054 | 0.060 | L | 0.148 | -0.012 | 0.198 | 72 | 31 |
| 15 | 0.160 | 72 | 0.137 | 0.062 | 0.052 | E | 0.100 | -0.014 | 0.272 | 73 | 30 |
| 16 | 0.189 | 85 | 0.142 | 0.064 | 0.036 | | 0.041 | -0.007 | 0.210 | 73 | 50 |
| 17 | 0.125 | 100 | 0.105 | 0.049 | 0.020 | | 0.012 | -0.002 | 0.150 | 74 | 60 |
| 18 | 0.076 | 82 | 0.075 | 0.044 | 0.001 | | 0.023 | -0.003 | 0.034 | 75 | 60 |
| 19 | 0.022 | 101 | 0.017 | 0.040 | 0.005 | | 0.013 | -0.001 | 0.048 | 73 | 62 |
| 20 | 0.055 | 100 | 0.049 | 0.048 | 0.000 | | 0.015 | -0.000 | 0.145 | 74 | 53 |
| 21 | 0.073 | 141 | 0.073 | 0.048 | 0.000 | | 0.173 | -0.008 | 0.029 | 72 | 39 |
| 22 | 0.015 | 10 | 0.053 | 0.018 | 0.078 | | 0.644 | -0.004 | 0.106 | 71 | 30 |
| 23 | 0.132 | 10 | 0.002 | 0.040 | 0.258 | | 0.386 | -0.003 | 0.002 | 72 | 36 |
| 24 | 0.182 | 19 | 0.001 | 0.038 | 0.181 | | 0.262 | -0.009 | 0.037 | 72 | 38 |
| 25 | 0.099 | 107 | 0.018 | 0.036 | 0.081 | | 0.198 | -0.005 | 0.025 | 72 | 55 |
| 26 | 0.013 | 213 | 0.013 | 0.016 | 0.000 | | 0.006 | -0.000 | 0.001 | 72 | 56 |
| 27 | 0.001 | 77 | 0.001 | 0.018 | 0.000 | | 0.007 | -0.000 | 0.001 | 73 | 67 |
| 28 | 0.061 | | 0.047 | 0.022 | 0.014 | | 0.038 | -0.002 | 0.093 | 71 | 57 |
| SUM | 3.810 | - | 1.284 | 1.100 | 2.526 | N.A. | 5.402 | -0.202 | 2.557 | - | - |
| AVG | 0.123 | 34 | 0.041 | 0.039 | 0.081 | N.A. | 0.174 | -0.007 | 0.082 | 72 | 48 |
| NBS | Q402 | N400 | Q400 | Q403 | Q401 | | Q410 | Q415 | Q417 | N406 | N113 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM
MONTHLY REPORT
ENVIRONMENTAL SUMMARY

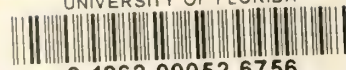
SITE: RADEMAKER CORP.-LIQUID SYSTEM
REPORT PERIOD: MARCH, 1979

SOLAP/2009-79/03

| DAY OF MONTH | TOTAL INSOLATION BTU/SQ. FT | DIFUSE INSOLATION BTU/SQ. FT | AMBIENT TEMPERATURE DEG F | DAYTIME AMBIENT TEMP DEG F | RELATIVE HUMIDITY PERCENT | WIND DIRECTION DEGREES | WIND SPEED M.P.H. |
|--------------------|-----------------------------------|------------------------------------|---------------------------------|-------------------------------------|---------------------------------|------------------------------|-------------------------|
| 1 | 287 | NOT | 45 | 48 | NOT | NOT | NOT |
| 2 | 1082 | | 45 | 52 | | | |
| 3 | 227 | | 54 | 57 | | | |
| 4 | 920 | | 54 | 60 | | | |
| 5 | 214 | | 38 | 40 | | | |
| 6 | 2270 | | 42 | 52 | | | |
| 7 | 638 | | 43 | 53 | | | |
| 8 | 905 | | 45 | 51 | | | |
| 9 | 808 | | 45 | 47 | | | |
| 10 | 1273 | | 38 | 45 | | | |
| 11 | 1038 | | 32 | 25 | | | |
| 12 | 2391 | | 31 | 55 | | | |
| 13 | 846 | | 51 | 58 | | | |
| 14 | 1906 | | 41 | 44 | | | |
| 15 | 2375 | | 37 | 35 | | | |
| 16 | 2424 | | 37 | 35 | | | |
| 17 | 2147 | | 50 | 66 | | | |
| 18 | 1709 | | 63 | 77 | | | |
| 19 | 687 | | 60 | 70 | | | |
| 20 | 631 | | 62 | 69 | | | |
| 21 | 1509 | | 64 | 70 | | | |
| 22 | 740 | | 63 | 72 | | | |
| 23 | 914 | | 57 | 59 | | | |
| 24 | 157 | | 39 | 37 | | | |
| 25 | 501 | | 30 | 31 | | | |
| 26 | 1237 | | 36 | 40 | | | |
| 27 | 478 | | 38 | 40 | | | |
| 28 | 1077 | | 55 | 63 | | | |
| 29 | 579 | | 66 | 67 | | | |
| 30 | 965 | | 67 | 72 | | | |
| 31 | 191 | | 57 | 57 | | | |
| SUM | 33125 | N.A. | - | - | - | - | - |
| AVG | 1069 | N.A. | 48 | 54 | N.A. | N.A. | N.A. |
| NBS ID | 9001 | | N113 | | | N115 | N114 |

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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